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(54) **COMPOSITION ET METHODE DE PRODUCTION DE PATE DE BOIS**

(54) **COMPOSITION AND METHOD FOR PRODUCING WOOD PULP**

(57) Composition et procédé servant à faire cuire le bois dans une lessive de cuisson pour former une pâte. Cette composition, qui est ajoutée à la lessive de cuisson, contient de l'huile de ricin alkoxydée. L'huile de ricin peut être utilisée seule ou en combinaison avec divers surfactants.

(57) A composition and process for cooking wood in a cooking liquor to form pulp is disclosed. The composition, which is added to the cooking liquor, contains an alkoxylated castor oil. The castor oil can be used alone or in combination with various surfactants.

Abstract of the Disclosure

A composition and process for cooking wood in a cooking liquor to form pulp is disclosed. The composition, which is added to the cooking liquor, contains an alkoxylated castor oil. The castor oil can be used alone or in combination with various surfactants.

PATENT

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COMPOSITION AND METHOD FOR PRODUCING WOOD PULP

Field of the Invention

The present invention is generally directed to a process for producing paper from wood pulp, and more particularly to a composition containing a castor oil derivative, such as an ethoxylated castor oil that is used for producing pulp from wood chips.

Background of the Invention

The majority of corrugated boxes, paper grocery bags, fine papers, and market pulps are produced by a sulfate pulping process known as "Kraft" pulping. The process is characterized by the fact that sodium sulfide is added to the medium that is used to cook the wood chips and produce pulp. When this technique was introduced over a century ago, the addition of sodium sulfide produced a dramatic improvement in pulp strength, pulp yield, and durability of the paper made therefrom.

In the typical Kraft digestion process, wood chips are added to an aqueous medium consisting mostly of white liquor which will be transformed into black liquor during the cook. In general, the liquor in which the wood chips are cooked, or cooking liquor, comprises a mixture of black and white liquor, the black liquor being liquor added back to the cooking vessel, or digester, from a prior batch of wood chips and the white liquor being a freshly prepared alkaline solution. Black liquor varies considerably among different mills depending on the white liquor used, the wood employed, and the method of cooking. Typical white liquor is a solution of sodium hydroxide, sodium carbonate, sodium sulfate, sodium sulfide and various inorganic materials. White liquor solubilizes the pulp and removes the lignin from the wood fibers.

The largest part of the organic matter removed from the wood during cooking is combined chemically with sodium hydroxide in the form of sodium salts. Some of these compounds are resin and fatty acid soaps which account for the intense foaming properties of black liquor. In addition, organic sulfur compounds and mercaptans, which give the characteristic odor to the sulfate-containing black liquor, and small amounts of sodium sulfate, silica and other impurities such as lime, oxide, alumina, potash, and sodium chloride are present in the black liquor.

In the pulping process, pre-sized wood chips are subjected to the alkaline reagents at elevated temperatures and pressures in a digester vessel. Generally, temperatures range from about 250°F to about 350°F and pressures range from about 60 psi/g to about 130 psi/g. Digestion time may range from 30 minutes to 10 hours, depending on the process conditions and the desired pulp/paper characteristics.

The reaction conditions present during the cook, or digestion, cause lignin--the amorphous polymeric binder found in wood fibers--to be hydrolyzed. Ideally, wood chips are digested only long enough to dissolve sufficient lignin to free the cellulosic wood fibers but maintain sufficient lignin intact to provide added strength to the paper. The pulping process attempts to maximize pulp yield, which is defined as the dry weight of pulp produced per unit dry weight of wood consumed.

After sufficient lignin has been dissolved to free the cellulosic wood fibers, the digester charge is blown into a receiving vessel, or blow tank. The sudden drop in pressure from the digester to the blow tank causes additional mechanical breakup of the wood fibers. In some papermaking applications, the

residual lignin is removed to produce papers without the characteristic brown color of Kraft paper. In producing linerboard or Kraft paper, however, the lignin residue remains in the papermaking pulp so that the highest possible strength of wood pulp is achieved.

Ideally, each of the wood chips blown from the digester into the blow tank is broken down into separate wood fibers. In practice, however, some of the wood chips fail to completely separate due, in part, to the undissolved lignin remaining in the pulp. These unseparated particles are removed from the wood pulp by passing the pulp through a screen having openings of a predetermined size. In the pulping industry, the standard test screen employed is flat with .01 inch slots therethrough.

The materials that are recovered by this screening process are known as "rejects". The rejects include wood fibers that could be used to produce paper. Accordingly, it is highly desirable to decrease the amount of rejects. One method of lowering the amount of rejects is by increasing the digestion time or by creating more severe hydrolysis conditions. Such conditions, however, increase the costs involved and cause some of the cellulose in the wood chips to be hydrolyzed and rendered unusable.

After contact with liquor in the digester, inorganics, any unused surfactants that may have been added, and solubilized lignin and resins are removed from the pulp in one or more washing steps. Temperatures in the digestion and washing stages typically vary from about 250°F to 340°F and 100°F to 200°F, respectively. After washing, the pulp may be subjected to further bleaching or purification treatments as desired before being sheeted and dried,

or prepared for sale, or further utilized in making paper.

A Kappa number corresponds directly to the amount of lignin remaining in the pulp. Generally, the higher the Kappa number, the more lignin present in the pulp and, therefore, the higher the pulp yield. The Kappa number generally decreases as the digestion time is increased or the alkalinity of the cooking liquor is increased. The goal in such Kraft papermaking processes is to retain as much lignin as possible in order to enhance strength and to reduce the cost, while maintaining the uniformity of the cook. More uniform cooks result in a decreased percentage of rejects and, thereby, reduce costs for running paper mills.

Cooking, or digestion, of the pulp may be terminated when the amount of rejects in the pulp is reduced to an acceptable level. Substantial yield and quality advantages are achieved if the wood chips are cooked to a higher lignin content. As a result, an increase in a Kappa number target by the use of thinner chips can result in a substantial cost savings. However, the thickness of chips obtainable on a commercial scale is always variable. A major portion of the total rejects frequently originate from a relatively small fraction of the chips having the greatest thickness. The objective in every pulping process is to achieve a lower percentage of rejects.

In recent years, the focus of the paper making industry has turned to various conservation efforts and to other environmentally related concerns. For instance, efforts have been undertaken to utilize as much of the wood as possible during the pulping process. Besides the obvious economic advantages, increasing the efficiency of wood conversion to pulp

lowers raw material requirements, preserving the amount of trees that need to be harvested for producing the paper products.

Besides decreasing wood consumption, other efforts have been undertaken to decrease the quantity of chemicals added to the wood in order to convert the wood into pulp. Once these chemicals become used and exhausted during the pulping process, they accumulate various waste products. If the chemicals are not recycled, they must be disposed of according to very strict governmental regulations. By reducing the quantity of chemicals added to the wood, less waste is generated for disposal, which not only provides economic advantages, but also places less burdens on the environment.

In one aspect, improvements to the wood pulping process have been achieved through the inclusion of chemical additives in the cooking liquor. For instance, in U.S. Patent No. 5,298,120 to Blackstone entitled "Composition for Enhancing the Pulping of Wood Chips" and in U.S. Patent No. 5,501,796 to Blackstone et al. entitled "Pulping Wood Using Fatty Acid Esters of Polyoxyalkene Glycols to Enhance Pulping Uniformity and Pulp Yield", which are both incorporated herein by reference, various surfactants are disclosed that are added to the cooking liquor or to the wood chips in order to enhance cooking uniformity, to increase the yield of pulp produced, to reduce the amount of cooking liquor, and to decrease the amount of rejects. The surfactants are directed to esters of ethylene oxide-propylene oxide block copolymers and to esters of polyoxyalkene glycols.

U.S. Patent No. 3,448,004 to Buckman, et al. is directed to the addition of an N,N-dimethylamide of a straight chain carboxylic acid to the cooking

chemicals used in the preparation of chemical pulp from wood chips. Buckman et al. states that the addition of the N,N-dimethylamide reduces the amount of cooking chemicals required in the process accompanied by increased yield and improved quality of the chemical pulp.

Other various surfactants and deresinating agents added to the cooking liquor during the production of wood pulp are disclosed in U.S. Patent No. 4,426,254 to Wood et al., U.S. Patent No. 2,999,045 to Mitchell et al., U.S. Patent No. 4,906,331 to Blackstone et al., and U.S. Patent No. 4,952,277 to Chen, et al..

The above prior art represents significant advances and improvements to the wood pulping process. The particular features of the present invention, however, have not heretofore been known and remain absent from the prior art. The present invention is directed to further improvements and advances in the process of producing wood pulp and in the process of producing paper therefrom.

Summary of the Invention

The present invention is directed to further advantages and improvements over prior art constructions in the paper making field. Accordingly, it is an object of the present invention to provide a composition and process for improving the cooking of wood chips during the production of pulp for making paper.

It is an object of the present invention to provide a composition and process for enhancing cooking uniformity of wood chips for producing pulp.

It is another object of the present invention to provide a composition and process for increasing the yield of pulp produced per ton of wood chips.

It is another object of the present invention to

provide a composition and process for reducing the amount of cooking liquor required to produce pulp.

It is a further object of the present invention to provide a composition and process for reducing the amount of solids contained in the black liquor of a pulping process.

It is another object of the present invention to provide a composition and process to decrease the amount of rejects produced during production of pulp.

It is a further object of the present invention to provide an economical and efficient process for producing pulp from wood.

Another object of the present invention is to provide a composition and process to decrease the impact of the Kraft pulping process on the environment and reduce the cost of treating waste materials produced thereby.

Still another object of the present invention is to provide a process for producing pulp which includes the steps of adding an alkoxylated castor oil to a cooking liquor.

Another object of the present invention is to provide a process for producing pulp which includes the step of adding to the cooking liquor an alkoxylated castor oil blended with other surfactants, such as an ester of a polyoxyalkene glycol.

These and other objects of the invention are achieved by providing a process for cooking wood in a cooking liquor medium comprising the steps of contacting the wood with a cooking liquor containing a composition comprising an alkoxylated castor oil. The wood is cooked to produce a pulp. The process can further include the step of producing paper from the pulp.

In one embodiment, the alkoxylated castor oil can

contain from about 5 moles to about 200 moles alkoxylate (per mole of castor oil), particularly from about 5 moles to about 80 moles alkoxylate, and in one preferred embodiment from about 16 moles to about 25 moles alkoxylate. The alkoxylated castor oil can be the reaction product of ethylene oxide and castor oil, the reaction product of propylene oxide and castor oil or mixtures thereof.

In general, the alkoxylated castor oil can be present in the composition in an amount from about 10 percent to about 100 percent by weight and particularly from about 40 percent to about 60 percent by weight. Prior to being diluted with water, the composition can be added to wood during the pulping process in an amount from about 0.2 pounds to about 0.4 pounds per ton of wood.

When added to wood chips, the composition of the present invention can be diluted with water. For instance, water can be added to the composition in an amount up to about 95 percent by weight, and particularly up to about 90 percent by weight. Once diluted with water, the composition can be added to the cooking liquor at a rate of from about 2 pounds to about 4 pounds per ton of wood.

The alkoxylated castor oil can be used alone or in combination with other surfactants and chemical agents. For instance, the composition can contain alkoxylated castor oil mixed with anthraquinone, esters of polyoxyalkene glycols, esters of ethylene oxide-propylene oxide block copolymers, and mixtures thereof. For example, in one embodiment, the composition can contain esters of block copolymers having the general formula:

$$HO(CH_2CH_2O)_x(\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_2O)_y(CH_2CH_2O)_zH$$

wherein X, Y and Z each have a value of at least 1.

In an alternative embodiment, the alkoxylated castor oil is combined with at least one ester of a polyoxyalkene glycol. For instance, the composition can contain a blend of esterified polyoxyalkene glycols, such as an esterified polyoxyethylene glycol and an esterified polyoxypropylene glycol. In particular, the esterified polyoxyethylene glycol can be the reaction product of polyoxyethylene glycol with stearic acid, while the esterified polyoxypropylene glycol can be the reaction product of polyoxypropylene glycol with oleic acid. In general, the esters of the polyoxyalkene glycols can be present in the composition in an amount from about 20 percent to about 70 percent by weight.

These and other objects of the present invention are also achieved by providing a composition for adding to an alkaline liquor for cooking wood to produce pulp. The composition includes an alkoxylated castor oil that is present in the composition in an amount of at least 10% by weight. The alkoxylated castor oil is contained in the composition in combination with a surfactant. The surfactant can be, for instance, a polyoxyalkene glycol and esters thereof, a block copolymer of a polyethylene oxide and polypropylene oxide and esters thereof, anthraquinone and mixtures thereof.

Other objects, features and aspects of the present invention are discussed in greater detail below.

Description of Preferred Embodiments

It is to be understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only and is not intended as limiting the broader aspects of the invention, which broader aspects are embodied in the exemplary construction.

In general, the present invention is directed to a composition and process for producing pulp from cellulosic materials such as wood chips. The process employees a chemical agent that acts as a dispersant and as a surfactant in the cooking liquor that is used in the digester to produce the pulp. When added to the cooking liquor, the composition of the present invention enhances cooking uniformity, increases pulp yield, reduces the amount of cooking liquor needed to produce the pulp, decreases the amount of rejects, and improves the quality of the pulp.

Broadly speaking, the composition of the present invention, in order to achieve the above-described benefits, contains a castor oil derivative, and in particular, an alkoxylated castor oil. For instance, the alkoxylated castor oil can be the reaction product of castor oil and ethylene oxide, the reaction product of castor oil and propylene oxide, or mixtures thereof. The alkoxylated castor oil can contain from about 5 moles to about 200 moles of alkoxylation, and particularly from about 5 moles to about 80 moles of alkoxylation. In one preferred embodiment of the present invention, the composition contains mixtures of an ethoxylated castor oil containing 16 moles of ethoxylation and an ethoxylated castor oil containing 25 of moles ethoxylation.

At the present time, it is unknown why the addition of an alkoxylated castor oil to the cooking

liquor produces the above-described benefits and advantages. It is believed, however, that an alkoxylated castor oil is well suited for use in wood pulping processes due to its resiliency and ability to remain stable within an alkaline cooking liquor at high temperatures. In particular, an alkoxylated castor oil contains an ether linkage between the polyoxyalkylene glycol portion of the molecule and the fatty acid backbone which does not break down when exposed to heat in an alkaline composition thus maintaining the functional part of the compound in tact.

In general, prior to being diluted with water, the composition of the present invention can contain from about 10 percent to about 100 percent by weight of the alkoxylated castor oil, and preferably from about 40 percent by weight to about 60 percent by weight. More particularly, the amount of alkoxylated castor oil contained within the composition will depend upon the particular application and the other ingredients added to the cooking liquor.

Based upon its concentrated form (not containing any water), the composition of the present invention, for most applications, can be added to wood chips for forming pulp in an amount from about 0.2 pounds to about 0.4 pounds per ton of wood. Additional amounts of the composition may be added to the cooking liquor. It has been discovered, however, that additional amounts typically do not provide any further benefits.

In general, the composition of the present invention should be diluted with water prior to being added to the cooking liquor. Water can be added to the composition in an amount up to about 95 percent by weight and particularly up to about 90 percent by weight. Once diluted with water, the resulting

solution can be added to the cooking liquor in an amount from about 2 pounds to about 4 pounds per ton of wood. In adding the composition of the present invention to the digester, the composition can be mixed with the alkaline cooking liquor before contacting the chips or can be fed in line with the cooking liquor.

Besides being an effective dispersant and surfactant in its own right, it has also been unexpectedly discovered that alkoxylated castor oil synergistically improves the performance of other surfactants and chemical agents used in wood pulping processes. In this regard, the present invention is also directed to the use of alkoxylated castor oil in combination with other wood pulping agents.

For instance, the composition of the present invention can contain an alkoxylated castor oil in combination with such known surfactants as polyoxyethylene-polyoxypropylene block copolymers as disclosed in U.S. Patent No. 3,909,345 to Parker, et al. which is incorporated herein by reference, anthraquinone, polyoxyalkene glycols, esters of polyoxyalkene glycols as disclosed in U.S. Patent No. 5,501,769 which was referenced above, and esters of ethylene oxide-propylene oxide block copolymers as disclosed in U.S. Patent No. 5,298,120 which was also referenced above. Alkoxylated castor oil can be combined with the above surfactants and mixed with the cooking liquor or can be added separately to the cooking liquor.

For example, in one embodiment, alkoxylated castor oil can be used in combination with esters of ethylene oxide-propylene oxide block copolymers as can be represented by the following general formula:

$$HO(CH_2CH_2O)_x(\underset{\displaystyle CH_3}{\underset{|}{CH}}CH_2O)_y(CH_2CH_2O)_zH$$

in which X, Y, and Z are integers having a value of 1 or more. The block copolymers can be esterified by reacting them with, for instance, a fatty acid. In general, any fatty acid may be used. Particular fatty acids include saturated and unsaturated fatty monoacids and diacids having from about 4 to about 22 carbon atoms. Such fatty acids include maleic acid, stearic acid, adipic acid, palmitic acid, abietic acid, linoleic acid, and oleic acid. When present in the composition, the esterified block copolymers can be present in an amount from about 20 percent to about 70 percent by weight, and particularly from about 40 percent to about 65 percent by weight.

In an alternative embodiment, instead of using the above esterified block copolymers or in addition to using the above esterified block copolymers, esters of polyoxyalkene glycols are combined with the alkoxylated castor oil. For instance, the composition can contain blends of esterified polyoxyalkene glycols, such as an esterified polyoxyethylene glycol combined with an esterified polyoxypropylene glycol. In order to esterify the polyoxyalkene glycols, the polyoxyalkene glycols can be reacted with the above-described fatty acids.

In one of the preferred embodiments of the present invention, the composition of the present invention contains the following ingredients:

30% to 40% by weight of an ethoxylated castor oil containing 25 moles of ethoxylation

5% to about 10% by weight of an ethoxylated castor oil containing 16 moles of ethoxylation

25% to about 35% by weight of a polyoxyethylene glycol containing 40 moles of ethoxylation that has been esterified with stearic acid

25% to about 35% by weight of a polyoxypropylene glycol that has been esterified with oleic acid

Besides polyoxyalkene glycols, as described above, the alkoxylated castor oil of the present invention can also be used in combination with anthraquinone. For instance, in one embodiment, the composition can contain about 10 percent by weight alkoxylated castor oil combined with about 25 percent by weight of anthraquinone.

The present invention may be better understood with reference to the following examples.

EXAMPLE

The following test was performed in order to determine the effectiveness of the process and composition of the present invention.

Specifically, the following composition was formulated and mixed with a cooking liquor during the production of wood pulp:

36% by weight ethoxylated castor oil containing 25 moles of ethoxylation

8% by weight castor oil containing 16 moles of ethoxylation

28% by weight of the reaction product of a polyoxyethylene glycol with stearic acid

28% by weight of the reaction product of a polyoxypropylene glycol reacted with oleic acid

The above composition was diluted with 90 percent by weight water. The resulting aqueous solution was added to the cooking liquor at a rate of 2 pounds per ton of wood chips. The wood chips being processed were pine at a rate of from about 500 to about 550 tons per day. The trial period lasted six days.

During the trial period, it was observed that digester production increased in comparison to trials in which the cooking liquor did not contain the additive. It was also observed that the total dissolved solids contained in the cooking liquor declined which further indicates an increase in yield.

During the trial period, viscosity and kappa number data was collected. This data did not show an improvement. Chip shute level control problems occurred during the trial period, however, which is believed to account for the results. It is believed that if such problems were not experienced, the kappa number and the viscosity would have increased.

These and other modifications to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention which is more particularly set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to limit the invention so further described in such appended claims.

WHAT IS CLAIMED IS:

1. A process for cooking wood in a cooking liquor medium comprising the steps of:

contacting wood with a composition comprising an alkoxylated castor oil; and

cooking said wood with said composition in an alkaline liquor to produce a pulp.

2. A process as defined in claim 1, further comprising the step of producing paper from said pulp.

3. A process as defined in claim 1, wherein said alkoxylated castor oil contains from about 5 moles to about 200 moles of alkoxylation.

4. A process as defined in claim 1, wherein said composition further comprises esters of block copolymers having the general formula:

$$HO(CH_2CH_2O)_x(\underset{\substack{|\\ CH_3}}{C}HCH_2O)_y(CH_2CH_2O)_zH$$

wherein X, Y, and Z each have a value of at least 1.

5. A process as defined in claim 1, wherein said composition further comprises an ester of a polyoxyalkene glycol.

6. A process as defined in claim 1, wherein said alkoxylated castor oil contains from about 5 moles to about 80 moles alkoxylate.

7. A process as defined in claim 1, wherein said composition further comprises anthraquinone.

8. A process as defined in claim 1, wherein said alkoxylated castor oil comprises an ethoxylated castor oil, said ethoxylated castor oil containing from about 16 moles to about 20 moles of ethoxylation.

9. A process for cooking wood in a cooking liquor medium comprising the steps of:

contacting said wood with a composition comprising an ethoxylated castor oil blended with a

material selected from the group consisting of block copolymers and esters thereof having the general formula:

$$HO(CH_2CH_2O)_x(\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_2O)_y(CH_2CH_2O)_zH$$

wherein X, Y, and Z each have a value of at least 1, a polyoxyalkene glycol and esters thereof, anthraquinone, and mixtures thereof; and

cooking said wood with said composition in an alkaline liquor to produce a pulp.

10. A process as defined in claim 9, wherein said ethoxylated castor oil is present within said composition in an amount from about 40 percent to about 60 percent by weight.

11. A process as defined in claim 9, wherein said composition comprises a blend of ethoxylated castor oils.

12. A process as defined in claim 9, wherein said composition comprises said ethoxylated castor oil blended with an ester of a polyoxyalkene glycol.

13. A process as defined in claim 12, wherein said ester of said polyoxyalkene glycol comprises a blend of an esterified polyoxyethylene glycol and an esterified polyoxypropylene glycol.

14. A process as defined in claim 13, wherein said esterified polyoxyethylene glycol comprises a reaction product of polyoxyethylene glycol with stearic acid, and wherein said esterified polyoxypropylene glycol comprises a reaction product of polyoxypropylene glycol with oleic acid.

15. A process as defined in claim 13, wherein said blend of said esterified polyoxyethylene glycol and said esterified polyoxypropylene glycol is present within said composition in an amount from about 40

percent to about 70 percent by weight.

16. A process as defined in claim 9, wherein said composition is added to up to about 95 percent by weight water prior to being contacted with said wood.

17. A process as defined in claim 16, wherein said aqueous composition is added to said wood in an amount from about 2 pounds to about 4 pounds per ton of wood.

18. A process as defined in claim 11, wherein said blend of ethoxylated castor oils comprises an ethoxylated castor oil containing 16 moles of ethoxylation and an ethoxylated castor oil containing 25 moles of ethoxylation.

19. A composition for adding to an alkaline liquor for cooking wood to produce a pulp, said composition comprising:

an alkoxylated castor oil, said alkoxylated castor oil being present in said composition in an amount of at least 10 percent by weight; and

a surfactant comprising a material selected from the group consisting of a polyoxyalkene glycol and esters thereof, a block copolymer of a polyethylene oxide and polypropylene oxide and esters thereof, anthraquinone, and mixtures thereof.

20. A composition as defined in claim 19, wherein said alkoxylated castor oil comprises an ethoxylated castor oil having from about 5 moles to about 80 moles of ethoxylation.

21. A composition as defined in claim 19, wherein said surfactant comprises a blend of an esterified polyoxyethylene glycol with an esterified polyoxypropylene glycol.

22. A composition as defined in claim 21, wherein said esterified polyoxyethylene glycol comprises a reaction product of polyoxyethylene glycol

with stearic acid, and wherein said esterified polyoxypropylene glycol comprises a reaction product of polyoxypropylene glycol with oleic acid.

23. A composition as defined in claim 21, wherein said blend of said esterified polyoxyethylene glycol and said esterified polyoxypropylene glycol is present in said composition in an amount from about 20 percent to about 70 percent by weight.

24. A composition as defined in claim 21, wherein said alkoxylated castor oil comprises a blend of ethoxylated castor oils having from about 16 moles to about 25 moles of ethoxylation.

25. A composition as defined in claim 19, wherein said surfactant comprises an ester of an ethylene oxide-propylene oxide block copolymer.

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